

Amendments to the Title:

Please replace the title with the following:

~~OPTICAL PICKUP DRIVE DEVICE AND OPTICAL PICKUP FOCUS PULL-IN METHOD~~
OPTICAL PICKUP DRIVING APPARATUS AND OPTICAL PICKUP BEAM SPOT POSITIONING
METHOD

Amendments to the Specification:

Please add the following new paragraph after the title and before the paragraph on page 1:

THIS APPLICATION IS A U.S. NATIONAL PHASE APPLICATION OF PCT INTERNATIONAL APPLICATION PCT/JP2004/014673.

Please replace the paragraph, beginning at page 4, line 1, with the following rewritten paragraph:

Figure 10 is an optical information apparatus which records/reproduces data onto/from a two-layer optical disk according to a conventional technology. In Figure 910, a two-layer optical disk 109 is placed on a turn table 182 and rotated by a motor 164 as a rotation system. An optical head apparatus 155 is roughly moved to a track in which desired information of the two-layer optical disk 109 exists by a driving apparatus 151 of the optical head apparatus.

Please replace the paragraph, beginning at page 4, line 20, with the following rewritten paragraph:

Figure 11 is a flow chart showing a beam spot positioning method for the conventional two-layer optical disk, Figure 12 illustrates a focus error signal waveform and Figure 13 illustrates a positional relationship between the optical disk and objective lens during beam spot positioning for the conventional two-layer optical disk. In Figure 13, reference numeral 120 denotes a two-layer optical disk whose information recording layer has a two-layer structure made up of a first layer 120b and a second layer 120c and 130 denotes an objective lens. Reference numeral 170 denotes a focus driving apparatus which drives the objective lens 130 in a direction perpendicular to a principal plane including a surface 120a of the two-layer optical disk 120 and corresponds to the driving apparatus 151 in Figure 10. Furthermore, as shown in Figure 12, the focus error signal is a signal whose level-voltage fluctuates in a positive or negative direction in the vicinity of the recording surface with respect to a predetermined reference voltage E according to the distance from the objective lens 130 and two-layer optical disk 120.

Please replace the paragraph, beginning at page 5, line 16, with the following rewritten paragraph:

Hereinafter, a case of reproduction of information will be explained as an example according to the flow chart in Figure 11. When a reproduction command on the two-layer optical disk 120 is issued (S101), a laser diode (not shown) is caused to emit light (S102), then the focus driving apparatus 170 is driven (S103) and the objective lens 130 is moved within a predetermined movement range. The electric circuit 153 turns ON the focus servo (S104) and monitors the focus error signal of the first layer shown by a waveform A in Figure 12 when the objective lens 130 is moving. When it is detected that the objective lens has reached point B in Figure 11 which is an in-focus point of the first layer 120b (S105), the focus servo is started (S106) using this focus error signal of the first layer 120b as a control signal, a focus jump is made to point D in Figure 11 which is the position of the in-focus point of the first layer 120c (S107) (this operation is carried out as a movement of the objective lens 130 from a state in

which the beam spot is positioned at the first layer 120b shown in Figure 13(b) to a state in which the beam spot is positioned at the ~~first~~second layer 120c shown in Figure 13(c)), the focus servo is started (S108) using the focus error signal of the ~~first~~second layer 120c shown by a waveform A-C in Figure 12 as a control signal and a data read of the second layer is carried out (S109).

Please replace the paragraph, beginning at page 6, line 16, with the following rewritten paragraph:

According to the beam spot positioning method for the above described two-layer optical disk, when a data read is performed from the ~~first~~second layer 120c, the focus servo of the first layer 120b is started first, and then a focus jump is made to start the focus servo for the ~~first~~second layer 120c. For this reason, a time is required until a data read of the second layer.

Please replace the paragraph, beginning at page 7, line 7, with the following rewritten paragraph:

Figure 14 is a flow chart showing a beam spot positioning method for a two-layer optical disk of the conventional example, Figure 15 illustrates a focus error signal waveform and Figure 13 illustrates the positional relationship between the two-layer optical disk 120 and objective lens 130 during beam spot positioning. Hereinafter, a case of reproduction of information will be explained as an example according to the flow chart in Figure 14.

Please replace the paragraph, beginning at page 7, line 16, with the following rewritten paragraph:

When a reproduction command for the two-layer optical disk 120 is issued (S201), the laser diode is caused to emit light (initial state shown in Figure ~~12~~13(a)) (S202). Then, the focus driving apparatus 170 moves the objective lens 130 in a direction perpendicular to the information recording surface of the two-layer optical disk 120 within a predetermined range of distance (S203). As the objective lens 130 moves, the electric circuit 153 starts to detect the focus error signal of the first layer 120b shown by a signal waveform A in Figure 15 (S204), and detects a period G during which the ~~level~~ voltage of the focus error signal is lower than a predetermined focus error signal detection slice level voltage F of the first layer ~~122~~120b.

Please replace the paragraph, beginning at page 8, line 9, with the following rewritten paragraph:

Next, the focus error signal C of the ~~first~~second layer 120c indicated by a signal waveform C in Figure 15 is monitored and if it is detected that the objective lens 130 has reached the position corresponding to an in-focus point D of the ~~first~~second layer 120c (S206), the focus servo is started using the second layer focus error signal C as a control signal (S208) and a data read of the second layer is performed (S209).

Please replace the paragraph, beginning at page 8, line 17, with the following rewritten paragraph:

However, the above described conventional beam spot positioning method has the following problems. That is, as shown in Figure 15, the focus error signals of the first layer 120b and ~~first-second~~ layer 120c are detected by detecting the waveforms A, B, but this detection is performed by detecting the ~~level-voltage~~ at a peak of the waveform or a position corresponding to predetermined displacement from a focus error signal reference voltage E. At this time, if, for example, the reflective index of the ~~first-second~~ layer 120c is low and the peak and ~~level-voltage~~ corresponding to the focus error signal of the ~~first-second~~ layer 120c cannot be detected, the objective lens 130 may continue to move in search of the focus error signal of the second layer, and collide with the optical disk 120, causing damage to the objective lens 130 or optical disk 120.

Please replace the paragraph, beginning at page 9, line 8, with the following rewritten paragraph:

Furthermore, when the reflective index of the first layer 120b is low and the focus error signal of the first layer 120b cannot be detected for the same reason as that described above, the focus error signal of the ~~first-second~~ layer 120c may be mistaken for the focus error signal of the first layer and the objective lens 130 may continue to move in search of the (inexistent) focus error signal of the ~~first-second~~ layer 120c, and finally collide with the optical disk 120, causing damage to the objective lens 130 or optical disk 120.

Please replace the paragraph, beginning at page 10, line 13, with the following rewritten paragraph:

control means of controlling said moving means based on a ~~level-voltage~~ of a focus error signal based on reflected light from said optical spot,

Please replace the paragraph, beginning at page 10, line 16, with the following rewritten paragraph:

wherein said control means controls said moving means so that said moving means moves said objective lens toward said recording surface, and when said control means detects that the ~~level-voltage~~ of said focus error signal has reached a first slice level voltage corresponding to displacement of predetermined magnitude from a reference potential, said moving means moves said objective lens toward said recording surface by a maximum of an upper limit of a predetermined amount of movement, and when the amount of movement of said objective lens has reached said predetermined amount of movement, said moving means moves said objective lens away from said recording surface, and

Please replace the paragraph, beginning at page 11, line 10, with the following rewritten paragraph:

The 2nd aspect of the present invention is the optical pickup driving apparatus according to the 1st aspect of the present invention, wherein when said control means newly detects that the ~~level-voltage~~ of said focus error signal has reached a third slice level voltage corresponding

to displacement of predetermined magnitude from said reference potential before the amount of movement of said objective lens reaches said predetermined amount of movement, said control means controls beam spot positioning so as to focus the optical spot.

Please replace the paragraph, beginning at page 11, line 21, with the following rewritten paragraph:

The 3rd aspect of the present invention is the optical pickup driving apparatus according to the 1st or the 2nd aspect of the present invention, wherein the ~~level-voltage~~ of said focus error signal alters in positive and negative directions with respect to said reference potential according to the movement of said objective lens, and

Please replace the paragraph, beginning at page 12, line 12, with the following rewritten paragraph:

The 5th aspect of the present invention is the optical pickup driving apparatus according to the 1st or the 2nd aspect of the present invention, wherein the ~~level-voltage~~ of said focus error signal fluctuates in positive and negative directions with respect to said reference potential according to the movement of said objective lens, and

Please replace the paragraph, beginning at page 14, line 18, with the following rewritten paragraph:

The 12th aspect of the present invention is the optical pickup driving apparatus according to the 1st or the 2nd aspect of the present invention, wherein when said control means detects that the ~~level~~ voltage of said focus error signal has reached a fourth slice level voltage at which the displacement from said reference potential is greater than the displacement of said first slice level voltage from said reference potential, said control means controls beam spot positioning so as to focus said optical spot.

Please replace the paragraph, beginning at page 16, line 10, with the following rewritten paragraph:

a control step of controlling said moving means based on a ~~level-voltage~~ of a focus error signal based on reflected light from said optical spot,

Please replace the paragraph, beginning at page 16, line 13, with the following rewritten paragraph:

wherein said control step controls said moving step so that said objective lens moves toward said recording surface, and when it is detected that the ~~level-voltage~~ of said focus error signal has reached a first slice level voltage corresponding to displacement of predetermined magnitude from a reference potential, said objective lens moves toward said recording surface by a maximum of an upper limit of a predetermined amount of movement, and when the amount of movement of said objective lens has reached said predetermined amount of movement, said objective lens moves away from said recording surface, and

Please replace the paragraph, beginning at page 17, line 7, with the following rewritten paragraph:

The 18th aspect of the present invention is the optical pickup beam spot positioning method according to the 17th aspect of the present invention, wherein in said control step, when it is newly detected that the ~~level~~-voltage of said focus error signal has reached a third slice level voltage corresponding to displacement of predetermined magnitude from said reference potential before the amount of movement of said objective lens reaches said predetermined amount of movement, control of beam spot positioning is performed so as to focus the optical spot.

Please replace the paragraph, beginning at page 17, line 17, with the following rewritten paragraph:

The 19th aspect of the present invention is the optical pickup beam spot positioning method according to the 17th or the 18th aspect of the present invention, wherein the ~~level~~ voltage of said focus error signal fluctuates in positive and negative directions with respect to said reference potential according to the movement of said objective lens, and

Please replace the paragraph, beginning at page 18, line 10, with the following rewritten paragraph:

The 21st aspect of the present invention is the optical pickup beam spot positioning method according to the 17th or the 18th aspect of the present invention, wherein the ~~level~~ voltage of said focus error signal fluctuates in positive and negative directions with respect to said reference potential according to the movement of said objective lens, and

Please replace the paragraph, beginning at page 20, line 17, with the following rewritten paragraph:

The 28th aspect of the present invention is the optical pickup beam spot positioning method according to the 17th or the 18th aspect of the present invention, wherein in said control step, when it is detected that the ~~level~~-voltage of said focus error signal has reached a fourth slice level voltage at which the displacement from said reference potential is greater than the displacement of said first slice level voltage from said reference potential, control of beam spot positioning is performed so as to focus said optical spot.

Please replace the paragraph, beginning at page 21, line 3, with the following rewritten paragraph:

The 29th aspect of the present invention is a program for causing a computer to function as control means of controlling said moving means based on a ~~level~~-voltage of a focus error signal based on reflected light from said optical spot of the optical pickup driving apparatus according to the 1st aspect of the present invention.

Please replace the paragraph, beginning at page 25, line 11, with the following rewritten paragraph:

Next, Figure 1(b) schematically shows the interior of the electric circuit 53. In the electric circuit 53, a decision circuit 53a is means of determining whether a focus error signal or tracking error signal obtained from the optical head apparatus 55 has reached a predetermined level-voltage or not and a control circuit 53b is means of performing control to drive various sections of the optical head apparatus 55 and when a decision is received from the decision circuit 53a, the control circuit 53b serves as means of performing control based on this decision. Furthermore, a memory 53c is means of storing the decision result of the decision circuit 53a as a history.

Please replace the paragraph, beginning at page 26, line 24, with the following rewritten paragraph:

At the same time, the decision means 53b of the electric circuit 53 monitors a focus error signal detected when the objective lens 131 is moving. As shown in Figure 3, the level-voltage of the focus error signal fluctuates in a positive or negative direction in the vicinity of a disk surface 121a, first layer 121b and second layer 121c with respect to a predetermined reference voltage E according to the distances from the objective lens 131 and optical disk 9. The decision means 53b detects a time point α at which the level-voltage of this focus error signal falls below a predetermined focus error signal detection slice level voltage G (S4) and stores the detection event in the memory 53c in the electric circuit 53 as a history. Then, in response to this detection, the control means 53b sets a limit value (L_{lim}) of an allowable amount of movement of the objective lens 131 (S5).

Please replace the paragraph, beginning at page 28, line 1, with the following rewritten paragraph:

The objective lens 131 continues to approach the optical disk 9 and during that period of time the decision means 53b of the electric circuit 53 determines whether the level-voltage of the focus error signal has fallen below the focus error signal detection slice level voltage G or not in the meantime (S6). When it is detected that the level-voltage of the focus error signal has fallen below the focus error signal detection slice level voltage G again, the focus servo control is turned ON for the first time (S7). At this time, as shown in Figure 3, the detection time point is β on the waveform C of the focus error signal of the second layer 121c.

Please replace the paragraph, beginning at page 29, line 13, with the following rewritten paragraph:

On the other hand, even if the objective lens 131 is moved to the limit value (L_{lim}) of the allowable amount of movement, if it is not determined that the level-voltage of the focus error signal has fallen below the focus error signal detection slice level voltage G, the control means 53b of the driving circuit 53 performs control so as to move the objective lens 131 away from the principal plane of the two-layer optical disk 121 from the position of limit value (L_{lim})(S11).

Please replace the paragraph, beginning at page 29, line 22, with the following rewritten paragraph:

The decision means 53b of the electric circuit 53 monitors the focus error signal detected when the objective lens 131 is moving away from the disk, determines whether the level voltage falls below the focus error signal detection slice level voltage G again or not and detects the time point at which it falls below the focus error signal detection slice level voltage G (S12). After the detection, the operations in steps S7 to S15 are executed and a data read is performed from the second layer 121c.

Please replace the paragraph, beginning at page 30, line 18, with the following rewritten paragraph:

(1) When the peaks and level-voltage corresponding to the focus error signal of the first layer 121b are detected but the peaks and level-voltage corresponding to the focus error signal of the second layer 121c cannot be detected:

Please replace the paragraph, beginning at page 31, line 9, with the following rewritten paragraph:

(2) When the peaks and level-voltage corresponding to the focus error signal of the first layer 121b are not detected but the peaks and level-voltage corresponding to the focus error signal of the second layer 121c are detected:

Please replace the paragraph, beginning at page 31, line 14, with the following rewritten paragraph:

In this case, the focus error signal of the second layer ~~122-121c~~ is mistaken for the first layer focus error signal, but the decision means 53b determines in S12 above that the focus error signal has fallen below the focus error signal detection slice level voltage G at the time point γ in the figure, the focus servo is turned ON (S7), operations in S9 to S13 and S15 are performed in that order with the in-focus point D regarded as a target for an in-focus detection in S8 and a data read is performed from the second layer 121c. That is, the optical head apparatus 55 detects the focus error signal of the second layer 121c twice, detects an in-focus point D and can execute a data read from the second layer 121c consequently.

Please replace the paragraph, beginning at page 32, line 3, with the following rewritten paragraph:

As shown above, after a predetermined level-voltage signal is detected as the focus error signal for the first time, a limit value is set in the amount of movement of the objective lens 131, the objective lens is moved from there in the opposite direction to detect the focus error signal again, and it is thereby possible to avoid collision between the objective lens 131 and optical disk 121, reliably detect the focus error signal a plurality of times and apply the focus servo to the second layer directly and in a short time.

Please replace the paragraph, beginning at page 35, line 14, with the following rewritten paragraph:

In Embodiment 1 above, the ~~level~~-voltage G which is lower than the reference voltage E is used as the slice level voltage used to detect a focus error signal of each recording layer, but the slice level voltage is not limited to this.

Please replace the paragraph, beginning at page 41, line 12, with the following rewritten paragraph:

As a still further example of the slice level voltage, it is possible to differentiate the magnitude of the above described slice level voltage between backward movement caused by the setting of a limit value (L_{lim}) of the allowable amount of movement and approaching movement before the backward movement started. That is, it is possible to cause the magnitude of the slice level voltage used for the detection of the focus error signal during backward movement to be smaller than the magnitude of the slice level voltage used for the first detection of the focus error signal. As shown in Figure 45, when the focus error signal is detected using the slice level voltage H, the first detection of the focus error signal is performed at time point δ . The second detection of the focus error signal should be performed originally at the time point ε , but if some trouble occurs for some reason, after the objective lens 131 is moved to the point (A) based on the limit value (L_{lim}) of the allowable amount of movement set at the first detection of the focus error signal, the objective lens 131 is moved away from the point (A) in the opposite direction and an attempt to detect the focus error signal is made again during the backward movement.

Please replace the paragraph, beginning at page 42, line 10, with the following rewritten paragraph:

When the focus error signal is detected during backward movement, if the slice level voltage H is used in the same way as the first detection, the detection is performed at the time point ζ shown in Figure 45, but when the failure of approaching movement is attributable to a reduction of the reflective index of the second layer 121c, for example, the ~~level~~-voltage of the focus error signal itself has not reached the slice level voltage H as shown by the dotted line in Figure 45, and therefore the focus error signal cannot be detected even during backward movement.

Please replace the paragraph, beginning at page 44, line 3, with the following rewritten paragraph:

In the explanations above, the slice level voltage H_{low} is used to detect a focus error signal during backward movement, but the slice level voltage H_{low} can also be used for the second detection of the focus error signal during approaching movement. In this case, the focus error signal can be detected at a time point ε' in Figure 45, in which case backward movement is not necessary and beam spot positioning can be further sped up. Furthermore, as far as the displacement is smaller than the displacement of the slice level voltage from the reference potential used for the first detection of the focus error signal, the displacement from the reference voltage E can be differentiated between approaching movement and backward movement in the second detection of the focus error signal.

Please replace the paragraph, beginning at page 44, line 21, with the following rewritten paragraph:

That is, in the case of a single-layer disk, compared to a multi-layer disk, the reflective index of the recording layer is larger and the level-voltage of the focus error signal is also larger, and therefore the decision means 53a sets H_{high} at which the displacement from the reference potential E is higher than the slice level voltage H used for the first detection of the focus error signal, and after the focus error signal being monitored reaches the slice level voltage H and a movement limit is set, if it is detected that this slice level voltage H_{high} has been reached, the decision means 53a detects an in-focus point. In Figure 45, that slice level voltage H_{high} has been reached is detected at the time point δ' and beam spot positioning is thereby performed to the in-focus point B of the first layer.

Please replace the paragraph, beginning at page 45, line 11, with the following rewritten paragraph:

In the above described explanations, the slice level voltage H is used to detect the focus error signal, and therefore H_{high} which is higher than the slice level voltage H is set, but it is also possible to set a level-voltage G_{low} (not shown) which is lower than the slice level voltage G with respect to the reference voltage E as the one corresponding to the case where the slice level voltage G is used to detect a focus error signal. That is, it is possible to set the level-voltage of the focus error signal to a slice level voltage such that the displacement from the reference potential is greater than the displacement of the slice level voltage used for the first detection of the focus error signal from the reference potential and detect that this slice level voltage has been reached.

Please replace the paragraph, beginning at page 46, line 21, with the following rewritten paragraph:

In Figure 6, a computer 100 is constructed of the optical information apparatus 67 according to Embodiments 1 to 6, an input apparatus 65 implemented by a keyboard, mouse or touch panel for inputting information, an arithmetic unit 64₁ implemented by a central processing unit (CPU), etc., which performs operations based on information input from the input apparatus 65 and information read from the optical information apparatus 67 and an output apparatus 61 implemented by a CRT, liquid crystal display apparatus or printer which displays information such as operation results of the arithmetic unit 64₁.

Please replace the paragraph, beginning at page 47, line 12, with the following rewritten paragraph:

In Figure 7, an optical disk player 77 is constructed of the optical information apparatus 67 according to Embodiments 1 to 6 and a decoder 66 as an apparatus which converts an information signal obtained from the optical information apparatus 67 to an image. Furthermore, this structure can also be used as a car navigation system. Furthermore, the apparatus of the present invention may also be used in a mode provided with a display apparatus ~~120-720~~ such as a liquid crystal monitor.

Please replace the paragraph, beginning at page 49, line 14, with the following rewritten paragraph:

Embodiments 7 to 10 have shown the output apparatus 61 and liquid crystal monitor 120 in Figures 6 to 9, but it is also possible to adopt a structure provided with only output terminals for connections with these devices. In this case, it is possible to provide a mode in which the output apparatus 61 and liquid crystal monitor 120 are not provided, but these devices are made available separately as required. Furthermore, Figure 7 and Figure 8 show no input apparatus, but it is also possible to adopt a mode provided with an input apparatus such as a keyboard, touch panel, mouse, remote control apparatus, etc. On the contrary, in Embodiments 7 to 10 above, it is also possible to adopt a mode in which the input apparatus is provided separately and only input terminals for connections with the input apparatus are included.

Please delete the paragraph, beginning at page 52, line 19:

~~Furthermore, the data structure of the present invention includes a database, data format, data table, data list or data type, etc.~~

Please replace the paragraph, beginning at page 52, line 22, with the following rewritten paragraph:

~~Furthermore, the recording medium includes a ROM, etc., and the transmission medium includes a transmission mechanism such as the Internet, light, radio wave, sound wave, etc.~~

Please delete the heading at page 53, line 9:

~~Industrial Applicability~~